Going dotty...identifying digital prints

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Abstract

The explosion in popularity of digital photography and printing has meant that people produce, use and buy digital output prints without really thinking about what they have in their hands. Is it inkjet or electrophotographic, chromogenic or dye diffusion? Although most home-made images are produced on inkjet printers, there are still a variety of media and support types that we need to be familiar with. Each of these types has different treatment, storage and display issues, so an accurate identification of the print type is essential.

This paper will provide an introduction to some of the various output systems, covering the possible paper and ink types, and how the image is produced on the paper. It will then move into preservation concerns for this new media.

It will also pose the question – "are these prints really photographs at all?"

Introduction

At the National Archives of Australia (NAA), the Conservation staff frequently receive calls and emails for information on printing and preserving digital images and their associated files. This paper will walk through how to identify several different types of print materials and what to do to preserve them.

In 2000 at the first AICCM Book and Paper Group Symposium, Katy Glen, then at the National Gallery of Victoria (NGV), introduced us to Non-Impact Printing in a paper titled, ironically, "An Introduction to Non-Impact Prints" (Glen 2000). In the intervening eight years much progress has been made with the refinement of inkjet inks, paper supports, light stability and availability. Ink sets now have improved colour gamuts and a wider choice of blacks. With the proliferation of desktop printing, these days every consumer can be a colour photographic 'master' in the comfort of their own home. Artists are also taking back control of printing their own images by buying large format inkjet printers.

When desktop inkjet photo printing first began, prints would rarely last more than a few years on display (Wilhelm 1999, 2006) before noticeable dye fade occurred. However, independent testing through Wilhelm Imaging Research in the USA has shown that today's inkjet prints can now outperform silver halide colour images for permanence on display, and in some instances can even parallel black and white prints (Wilhelm 2007).

In an effort to limit the length of this paper, only media that produce images of true photographic quality will be considered.

Print types

Inkjet

The predominant form of consumer made prints encountered will be the inkjet print on 'photo specific' paper. The media will generally be organic dye-based colours and black inks on a swellable paper, but pigment inks on microporous paper will also be used.

If the consumer has used a matched set of paper and ink, they may have achieved a reasonably permanent print. If, however, they have chosen to use third party inks or paper or both, their print may only have a display life of a few years (Wilhelm 2007; Hoffman 2006). Manufacturers design their inks and papers to work optimally together and in conjunction with their own printers, so once an unknown element is introduced, the manufacturer's permanence figures are null and void.

Images printed as snapshots will tend to be on glossy resin-coated papers which give a crisp image. Art prints may use fibre-based papers to simulate alternative, emulsion-free processes.

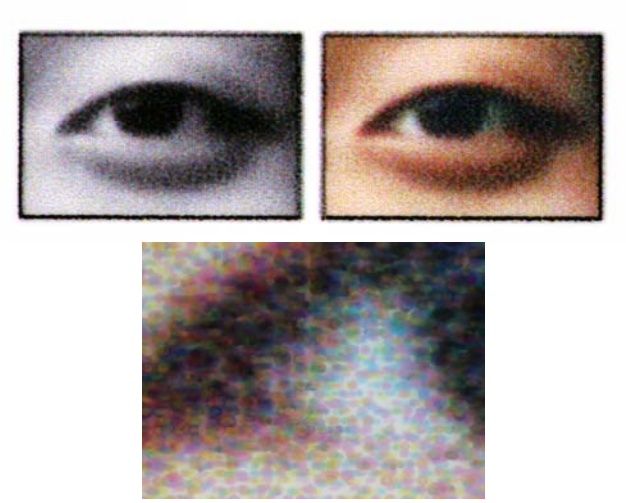

Figure 1: Example of image created by Liquid Inkjet - drop on demand - resin coated photo paper (top) without magnification; (bottom) x80 magnification[1]

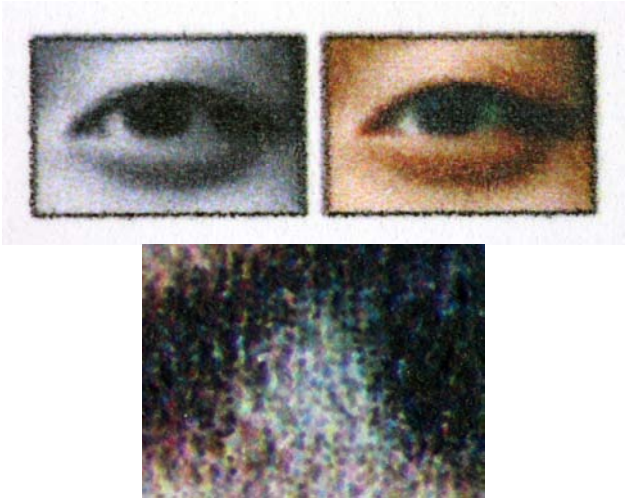

Figure 2: Example of image created by Liquid Inkjet - drop on demand – fine art paper (top) without magnification; (bottom) x80 magnification

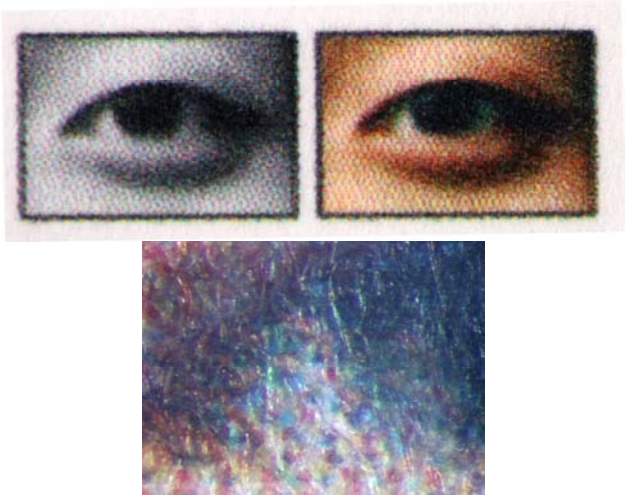

Figure 3: Example of image created by Liquid Inkjet – continuous (Iris or Giclée) (top) without magnification; (bottom) x80 magnification

Characteristics: Liquid Inkjet – drop on demand – resin coated photo paper

(Jürgens 1994, 2004, 2006a)

(Figure 1)[1]

- At normal viewing distance looks like continuous tone
- Very small drop size
- Drops will have well-defined edges as the ink can not bleed into paper fibres
- Dye-based inks will be absorbed well by the image carrying layer
- Pigment inks may sit more on the surface
- Various surface finishes – matte to high gloss
- Likely to have paper manufacturer's inscriptions on verso

Characteristics: Liquid inkjet – drop on demand – fine art paper

(Jürgens 1994, 2004, 2006a)

(Figure 2)

- At viewing distance may look like continuous tone
- Very small drop size
- Paper fibres will be visible through image
- Drops will have diffused edges due to absorption by paper fibres
- Drops will be incorporated into the paper surface, not sitting on surface
- Surface finish will most likely be matte
- Unlikely to have paper manufacturer's inscriptions on verso

Characteristics: Liquid inkjet – continuous – fine art paper (Iris or Giclée)

(Jürgens 1994, 2004, 2006a)

(Figure 3)

- At viewing distance will look like continuous tone
- Very small drop size which may vary within the image
- Areas of ink distributed in 'dots' will exhibit a rosette like pattern
- Drops will be diffused as they are absorbed by the paper fibres
- Drops will be incorporated into the surface of the paper, not sitting on surface
- Surface finish most likely to be matte
- May not be paper manufacturers inscriptions on verso

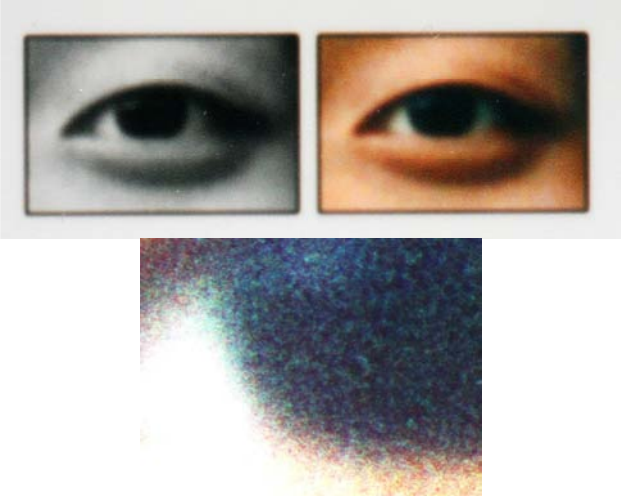

Figure 4: Example of image created by laser exposure to chromogenic paper (e.g. Lambda, Lightjet) (top) without magnification; (bottom) x80 magnification

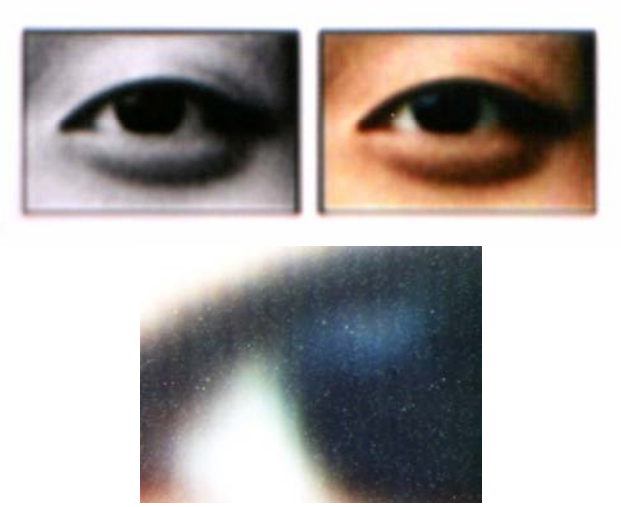

Figure 5: Example of image created by dye diffusion thermal transfer (top) without magnification; (bottom) x80 magnification

Figure 6: Example of image created by Fuji Pictrography (top) without magnification; (bottom) x25 magnification

Laser exposed chromogenic prints

(Jürgens 1994, 2004, 2006a)

These prints use basically the same photographic chemistry as analogue chromogenic (silver halide colour) prints. The dyes are incorporated into the paper in emulsion layers and have been slightly modified to be more receptive to laser (or light-emitting diode – LED) exposure rather than overall white light.

Due to incremental exposure of the chromogenic paper, pixel by pixel, to the laser or LED, the image may exhibit a soft linear pattern.

They will generally be on resin-coated papers, but these can have various surface finishes.

Characteristics: Laser exposed chromogenic prints

(Figure 4)

- Continuous tone image
- Resembles grain of a true photograph, not individual ink drops
- May be a slight linear pattern in image
- Colourants incorporated into the image carrying layer, not sitting on surface
- Smooth, resin coated papers with no paper fibres present
- Surface finish can vary from matte to glossy
- May have paper manufacturer's inscription on the verso

Dye diffusion thermal transfer (also known as dye sublimation prints)

(Jürgens 1994, 2004, 2006a)

These images are produced by dyes moving from a donor ribbon to a receiver paper. The ribbons consist of four separate sections: yellow, magenta and cyan dyes and a UV-filtering overcoat. The ribbon is polyester with the dyes locked into this plastic. The ribbon/dyes are heated in subsequent sections while in contact with the receiver paper. The heat opens the structure of the polyester ribbon and sublimates each solid dye and finally the UV overcoat one by one. The dyes, now in their vapour phase, move into the heated polyester coating of the receiving paper. The paper's polyester molecules likewise open when heated to receive the dyes, and then close around the dye molecules as they cool. The dye layers and finally the UV overcoat layer accumulate one colour at a time on the paper.

These prints are continuous tone images and have the look and feel of a chromogenic print. The print paper may be slightly thinner than chromogenic paper.

Characteristics: Dye diffusion thermal transfer (dye sublimation prints)

(Figure 5)

- Continuous tone image
- Colourants are incorporated into the image carrying layer, not sitting on surface
- May exhibit a linear or grid like pattern in the image
- Image appears soft under magnification
- May exhibit slight misregistration of colours at the edges
- Smooth finish, resin-coated paper, generally with a gloss surface
- May have paper manufacturer's inscriptions on the verso

Fuji Pictrography

(Jürgens 1994, 2004, 2006a)

A combination of many different processes, Pictrography produces continuous tone images on photographic paper.

A silver halide donor paper is exposed by three sets of laser diodes (RGB) producing a latent image. The donor paper is dampened, brought into contact with the receiving paper and heated. The heating initiates thermal development of CMY dyes incorporated into the donor paper, which then diffuse into the receptor coating of the receiving paper (Kipphan 2001).

Characteristics: Fuji Pictrography

(Figure 6)

- Continuous tone image
- Colourants are incorporated into the image carrying layer, not sitting on surface
- May exhibit a linear or grid like pattern in the image
- May exhibit misregistration of colours
- Smooth finish, resin-coated paper, generally with a gloss surface
- Surface is easily scratched
- May have paper manufacturer's inscriptions on the verso

Preservation of digital images

As with all materials incorporating organic dyes, these objects are susceptible to dye fade. Light, heat, humidity and pollutants will all damage these images (Hoffman 2006). Recent advances in inkjet ink manufacture have seen significant improvements in the light permanence of dye based inks and the permanence of pigment inks exposed to pollutants (Wilhelm 2007). Unless referenced, the following observations were made from testing conducted by the author during the *Collaborative Workshop in Photograph Conservation: Contemporary Photography: Digital Prints*[2] held in San Francisco in November 2006.

Inkjet dye-based images

- The inks produced by printer manufacturers for use in their printers have improved in light permanence dramatically in the last few years. Independent testing by Wilhelm Imaging Research since the 1990s has shown that dye-based inkjet inks have progressed from having a display life of less than one year (worst case) to now approaching 100 years.
- Third party discounted inks still show poor light permanence over time (Wilhelm 2007).
- Light levels for display of collection materials should be the same as for other artworks with fugitive media.
- These images are susceptible to water and humidity damage, however this is improving with new technologies. It is important to note that if the ink and paper are not matched, the ink will not be captured and held by the paper correctly (Jürgens 2006a; Williams 2006).
- Generally good resistance to gas induced fading (Wilhelm 2007).
- Organic solvents seem to be a safer choice than aqueous solvents from a conservation treatment point of view.

Inkjet pigment-based images

- Exhibit better light fastness than most of the dye based images, generally exhibiting around double the life expectancy, particularly for unframed prints (Wilhelm 1995).
- Light levels for display of collection materials should be the same as for other artworks with thin pigment layers, such as watercolours.

- Prone to gas induced fading, particularly from ozone although this characteristic is being improved (Wilhelm 2007).
- Good resistance to humidity and moisture, particularly if they are printed on microporous paper (Hoffman 2006)
- Aqueous and organic solvents affect the image.

Laser exposed chromogenic prints

- Fuji Crystal Archive are the most permanent (Wilhelm 2007).
- All types are less stable in light than pigment inkjet, and comparable to dye based inkjet prints.
- Light levels for display of collection materials should be the same as for other artworks with fugitive media.
- Good resistance to gas induced fading (Wilhelm 2007).
- Good resistance to humidity and moisture (Wilhelm 2007).
- Image stable with organic and aqueous solvents.

Dye sublimation prints

- Moderate light permanence (Wilhelm 2007).
- Light levels for display of collection materials should be the same as for other artworks with fugitive media.
- Good resistance to gas induced fading (Wilhelm 2007).
- Good resistance to humidity and moisture (Wilhelm 2007).
- Organic solvents will affect the image.
- Aqueous solvents may affect the image.

Fuji Pictrography

- Moderate light permanence – Fuji's own technical leaflet for the 4500N printer gives a print life of "...ten years or more" (Fujifilm nd)
- Light levels for display of collection materials should be the same as for other artworks with fugitive media.
- Unknown resistance to gas induced fading (Wilhelm 1993).
- Unknown resistance to humidity and moisture (Wilhelm 1993).
- Organic solvents may affect the image.
- Aqueous solvents will affect the image.

Conclusion

Similar to the identification of traditional prints and photographs, the identification of digital prints can be confusing. As technology advances and refines, image characteristics become more refined too, reducing some of the differences between the processes. Digital prints have some similarities with traditional ink-on-paper prints, but also with the laminar structure of analogue photographic prints. There can be many layers within the print paper, and different ways in which the image sits in or on the paper.

When material of this type becomes part of our collections, there is a good chance we will not know its exact composition or even the type of print that it is. Knowing how to identify print type characteristics will give us a few clues as to what it could be, but knowing definitively may be difficult. For this reason, the preservation of most of these images will have to be based on 'worst case' scenarios in terms of lighting and storage/display conditions, and a very conservative approach, which includes stringent solubility testing.

The technology will continue to advance and change, and as conservators tasked with looking after this material, we will have to keep our knowledge progressing too.

Acknowledgements

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Useful websites

www.imagepermanenceinstitute.com

aic.stanford.edu/sg/emg/index.html

aic.stanford.edu/sg/emg/juergens/

www.savemymemories.org

www.wilhelm-research.com

www.digitalsamplebook.com/home.htm

Notes

1. All images in this paper were taken by the author and are of prints included in Martin Jürgen's (2006b) "Contemporary Photography: Digital Prints: Sample Set".

2. The Andrew W. Mellon Foundation, *Collaborative Workshop in Photograph Conservation: Contemporary Photography: Digital Prints*, 6-10 November 2006, San Francisco Museum of Modern Art.

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